GEST

GODDARD EARTH SCIENCES AND TECHNOLOGY CENTER

Quarterly Report
Cooperative Agreement NCC5-494
Reporting Period: April 1, 2002 through June 30, 2002

Goddard Earth Sciences and Technology Center
University of Maryland, Baltimore County
1000 Hilltop Circle
Baltimore, MD 21250

UMBC

AN HONORS UNIVERSITY IN MARYLAND

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Technical Status Report

The following is a technical report of the progress made under Cooperative Agreement NCC5-494, the Goddard Earth Sciences and Technology Center (GEST). The period covered by this report is April 1, 2002 through June 30, 2002.

Overview of significant Activities

GEST celebrated another year in operation on May 11, 2002. We are now *Two Years* Old. Since establishing GEST, more than 120 faculty and support staff members have been hired into the organization.

Significant progress has been made in this second year in establishing GEST as a prominent center for research and international collaboration in the Earth and information sciences. The breadth of research interest has also grown, allowing the formation of five Research Group Leaders.

The Goddard Visiting Fellows Program in the Earth Sciences continued into its second year. This program provides the opportunity for selected Ph.D. scientists to pursue independent research in collaboration with scientists in the laboratories within the Earth Sciences Directorate either at the Goddard Space Flight Center or at the Goddard Institute for Space Studies.

During this second year, we added a permanent GEST researcher who is a faculty member at Hampton University, collaborating in oceanographic biology studies at the Wallops flight facility; a researcher on the faculty of Howard University joined GEST to collaborate in study of atmospheric aerosols. here are now several Caelum Research Scientists on the GEST scientific staff, and Caelum continues to provide the administrative support required by the Education and Visiting Scientists programs. Northrop Grumman has provided invaluable advice and support through representation on the GEST Executive Board, and plans to participate in this summer's new Coastal Research Fellowship program through mentoring and instrumentation support.

SUMMER PROGRAMS – GSSP Seminar Series

Climate Change and the Global Water Cycle

Visitors Center Auditorium, NASA Goddard Space Flight Center, Greenbelt, MD

In conjunction with the 2002 Graduate Student Summer Program in Earth System Science, the Goddard Earth Sciences and Technology Center (GEST) and the Earth Sciences Directorate of the Goddard Space Flight Center (GSFC) organized the second lecture series to held **June 11-14, 2002.** The intents of this series was to promote the understanding of current scientific knowledge about the challenges of global change, and how NASA supports the research underpinning this knowledge. Featured speakers and topics are listed below:

Tuesday June 11 — *Global Climate- Change, Past and Future*

9:00 am **Welcome** — **Mark Schoeberl, GSFC**

9:10 am Global Water and Energy Cycle:

NASA plans to address key uncertainties. — **Robert Schiffer, GEST**

10:30 am Water vapor, clouds, and the Earth radiant energy balance. — **William Collins, NCAR**

1:30 pm Climate change and expected impacts on the global water cycle. — **David Rind, GISS**

2:50 pm Global precipitation: observations, historical records, and trends. — **Bob Adler, GSFC**

Wednesday June 12 — *Water Cycle Predictability and Prediction*

9:00 am **Welcome** — **Robert Curran, GEST**

9:10 am Relationships between weather extremes, climate variability and long-term trends. — **Wayne Higgins, NOAA**

10:30 am Predictability of seasonal weather and precipitation patterns. — **Randy Koster, GSFC**

1:30 pm Severe hydrologic events: predictability and trends projection. — **Harry Lins, USGS**

2:50 pm Quantitative precipitation forecasts: prospects and outstanding science challenges. — **Chris Kummerow, Colorado State University**

Thursday June 13: — *Water Cycle Processes and Observations*

9:00 am **Welcome** — **Tom Low, GEST**

9:10 am Multi-scale cloud system simulation, dynamics and transport. — **Mitchell Moncrieff, NCAR**

10:30 am Ocean-atmosphere fluxes: surface interaction, PBL transport, and the role of moist convection. — **Mark Helfand, GSFC**

1:30 pm Land-atmosphere fluxes: evaporation, soil moisture, and run-off: observation and modeling. — **Matt Rodell, GSFC**

2:50 pm Land surface and hydrologic observations. — **Christa Peters-Lidard, GSFC**

Friday June 14: *Water Resources and Hydrologic Applications*

9:00 am Welcome **Robert Schiffer, GEST**

9:10 am Hydrologic modeling and prediction systems. **Guido Salvucci, Boston University**

10:30 am Dealing with spatial variability in landscape, soil, and hydrologic variables. **Dennis Lettenmaier, University of Washington**

1:30 pm Evapotranspiration and its estimation with satellite data. **Thomas Schmugge, USDA**

2:50 pm Impacts of water system management and human demand on water resources. **Soroosh Sorooshian, University of Arizona**

Research Milestones for the Reporting Period

GEST hosted this year's SPARC DA Workshop at UMBC Campus from Monday - Wednesday, June 10-12, 2002. A reception was held on Monday evening to formerly welcome all participants to the UMBC campus.

Topic outlines and speakers are listed below:

Monday - June 10th

Exploitation of ESA Atmospheric EO Measurements through Assimilation Techniques – **Claus Zehner**

Intercomparison of DATA Assimilation Products in the Polar Winter Stratopshere - **Gloria Manney**

Stratospheric Data Assimilation at the Met Office - **Richard Swinbank**

Meteorological analyses in the DAO: operational and reanalysis products – **Steven Pawson**

Sensitivity of middle atmospheric analyses to the representation of gravity-wave drag in the DAO's data assimilation system - **Shuhua Li**

On the extended stratospheric version of the 3D-Var/GEM model of the CMC/MRB using a new hybrid vertical coordinate - **Sandrine Edouard**

Recent developments in data assimilation system for the Canadian Middle Atmosphere Model (CMAM) - **Saroja Polavarapu**

Tuesday—June 11th—Topics

Reconstruction of Stratospheric Ozone Fields using Equivalent Latitude Mapping - **Cora Randall**

Global 3-D Ozone Estimation Using TOMS Column Ozone and Equivalent Latitude - **Douglas Allen**

An Overview of the SBUV/2 Operational and Reprocessed Ozone Data - **Shobha Kondragunta**

Use of 3D Global Ozone Fields to Simulate Satellite Data for Testing Data Assimilation and Inversion Algorithms - **John Hornstein**

Assimilation of ozone data in the ECMWF assimilation system - **Antje Dethof**

Ozone Assimilation at the Data Assimilation Office - **Ivanka Stajner**

Ozone assimilation at the Met Office - **David Jackson**

GOME ozone data assimilation and ozone forecasting at the KNMI - **Henk Eskes**

Ozone assimilation system with coupled GCM and CTM developed at MRI/JMA - **Toru Sasaki**

An ozone assimilation strategy using SBUV radiances - **Pawan K. Bhartia**

Wednesday—June 12th—Topics

Assimilaiton of /Envisat data at DARC - **William Lahoz**

4D-var assimilation of satellite data: uniqueness tests and CRISTA data assimilation - **Hendrik Elbern**

Towards operational chemical data assimilation at BIRA-IASB: BASCO - **Dominique Fonteyn**

An Overview of constituent assimilation efforts at NCAR, ACD - **Jean-Francois Lamarque**

Using Data Assimilation for Scientific Assessment of Atmospheric Chemistry - **David Lary**

GEST Faculty and Staff

GEST Administrative Staff

Two administrative staff members were hired during this reporting period, Dr. Robert Schiffer, GEST Chief Scientist, and Dr. Tom Low, GEST Associate Director. Dr. Low was formerly Manager, Applied Sciences and Lead contact with our consortium member Caelum Research Corporation. Dr. Robert Schiffer's background is in Atmospheric Sciences and Climate Research.

Contact information of each of the GEST administrative staff members are given in Appendix T-2 following this technical report.

GEST Technical Staff

The GEST Council has two new members, Tom Low and Robert Schiffer. A complete list of members of the GEST Council are noted in Table T-1 below.

Table T-1 GEST Council Members

Name	Position	Code	Section
Robert Curran	Director	900	Administration
Tom Low	Associate Director	900	"
L. Anathea Brooks	Assistant Director	900	"
Robert Schiffer	Chief Scientist	900	"
Dr. Julio Bacmeister	Faculty Group Leader	971	Seasonal and Interannual Prediction
Dr. Susan Hoban	Faculty Group Leader	103	Information Science and Technology
Dr. Steven Pawson	Faculty Group Leader	910	Climate and Trace Species
Dr. Susan Sakimoto	Faculty Group Leader	921	Land Surface and Hydrology
Dr. Alexander Smirnov	Faculty Group Leader	923	Aerosols and Clouds

Position advertisements appeared in *EOS and Science*. Information concerning these advertisements is provided in Table T-2.

Table T-2 Position advertisements published during this reporting period

Advertisement	No. of Positions	Publication Date	Closing Date
EOS	2	4/02	4/30/02
Science	2	4/02	4/30/02
The Chronological of Higher Education	1	4/02	5/15/02

Changes in the GEST technical staff during this reporting period are provided in the following two tables, Table T-3 and Table T- 4.

Table T-3 GEST technical and administrative staff hired during the reporting period

Name	Sponsor	Code
Mircea Grecu	Bob Adler	912
Hiro Hayashi	Steven Pawson	910
Daniel Jacob	C. Koblinsky	971
Lyapustin, Alexei	Robert Murphy	920
Tom Low	GEST Associate Director	900
Robert Schiffer	GEST Chief Scientist	900
Xiping Zeng	Bob Adler	912

Table T-4 GEST technical staff who have left during the present reporting period

Name	Sponsor	Code
Jiayu Zhou	William K. Lau	913

The subsequent positions that this individual went to is as follows: (J. Z.) NOAA National Weather Service Headquarters.

At the end of the reporting period GEST had approximately 100 research staff on board.

Submitted or Published Papers by GEST Researchers During this Reporting Period

The articles submitted or published during this reporting period are listed in the Appendix T-2 at the end this section of the report.

GEST Related Seminars for this Reporting Period

Several GEST related seminars are listed in Appendix T-3 at the end of this section of the report.

Proposals Submitted by GEST Researchers During this Reporting Period

Proposals submitted by UMBC GEST research faculty are listed in Appendix T-4 at the end of this section of the report.

Appendix T-1. GEST Administrative Staff

GEST Administrative Staff as of June 30, 2002.

Name	Position	Location	Telephone
Robert J. Curran	Director	UMBC/GSFC	410-455-8813 301-286-4403
Tom Low	Associate Director	UMBC/GSFC	410-455-8814 301-286-4403
L. Anathea Brooks	Assistant Director	UMBC/GSFC	301-286-4226
Robert Schiffer	Chief Scientist	GSFC	410-455-8810
Debbie Hicks	Business Manager	UMBC	410-455-8815
Grace Roscoe	Executive Assistant	UMBC	410-455-8808
Nancy Flowers	Administrative Assistant II	UMBC	410-455-8899
Cherrie Johnson	Administrative Assistant II	GSFC	301-286-4403
Deborah Belvedere	Program Assistant	GSFC	301-614-5809
Arlene Rustmann	Program Assistant	GSFC	301-614-5733
Frances Lilly	Visitor/School Coordinator	GSFC	301-286-4099
Denise Everhart	Student Support	GSFC	301-286-4099

Locations:

UMBC
UMBC Technology Center, South Campus
1450 S. Rolling Road, Suite 3.002
Baltimore, MD 21227

GSFC
NASA Goddard Space Flight Center
Mail Code 900.1
Bldg, 28, Room W223
Greenbelt, MD 20771

Appendix T-2. PUBLICATIONS, April 1, 2002 –June 30, 2002

Refereed

Paul Ginoux

Balkanski, Y., M. Schulz, T. Claquin, C. Moulin, and **P. Ginoux**, "Global emissions of mineral aerosol: formulation and validation using satellite imagery", Proceedings of Emissions of Chemical Species and Aerosol into the Atmosphere Workshop, Paris, France, June 19-22 2001, submitted April 2002.

Gregg, W., **P. Ginoux**, P. S. Schopf, and N. W. Casey, Phytoplankton and Iron: Validation of a global three-dimensional ocean biogeochemical model, Deep Sea Res., submitted April 2002.

Ginoux P., Effects of non-sphericity on mineral dust modeling, J. Geophys. Res., submitted May 2002.

Weaver, C., J. Joiner, and **P. Ginoux,** Mineral aerosol contamination of TOVS temperature and moisture retrievals, submitted to J. of Climate, May 2002.

Randall V. Martin 1 , Daniel J. Jacob 1 , Robert M. Yantosca 1 , Mian Chin 2,3 , **Paul Ginoux,** Global and regional decreases in Tropospheric oxidants from photochemical effects of aerosols, submitted to JGR, June 2002.

Gregg, W., M. E. Conkright, M. J. Behrenfeld, **P. Ginoux,** and N. W. Casey, Decadal changes in global ocean annual primary production, submitted to Science, June 2002.

Shuhua Li

Li, S., E. C. Cordero, D. J. Karoly, Transport out of the Antarctic polar vortex from a three-dimensional transport model, J. Geophys. Res., 107(D11), 1029/2001JD000508, 2002.

Judit Pap

SOLAR IRRADIANCE VARIATIONS OVER SOLAR CYCLES 21 TO 23, **J. M. Pap** (Goddard Earth Sciences and Technology Center, UMBC), J. Kuhn (Institute of Astronomy, University of Hawaii), H. Jones (NASA Goddard Space Flight Center, Southwestern Station/NSO), M. Turmon (Jet Propulsion Laboratory), N. Arge (NOAA Space Environment Center), W. Schmutz (World Radiation Center, PMOD), L. Floyd Interferometrics Inc., NRL).

Oreste Reale

Reale, O., and P. Dirmeyer, 2002: Modeling the effect of land-surface variability on precipitation variability. Part I: General response. In press on Journal of Hydrometeorology.

Reale, O., P. Dirmeyer, and A. Schlosser, 2002: Modeling the effect of land-surface variability on precipitation variability. Part II: Time- and space-scale structure. In press on Journal of Hydrometeorology.

Joan Rosenfield

"The impact of increasing carbon dioxide on ozone recovery" by **J. E. Rosenfield**, A. R. Douglass, and D. B. Considine, J. Geophys. Res., Vol. 107 (D6), 10.1029/2001JD000824, 2002.

Chung-Lin Shie

Convective Systems over the South China Sea: Cloud-Resolving Model Simulations W.-K. Tao, **C.-L. Shie,** D. Johnson, J. Simpson, S. Braun, R. H. Johnson and P. E. Ciesielski, (Submitted to *J. Atmos. Sci.)*

(Mesoscale Convective Systems during SCSMEX: Simulations with a Regional Climate Model and a Cloud-Resolving Model W.-K. Tao, Y. Wang, J.-H. Qian, **C.-L. Shie**, W. K.-M. Lau and R. Kakar (Submitted to a *Book published by the INDO-US Climate Research Program).*

Chaojiao Sun

Sun, C., Z. Hao, M. Ghil and J. D. Neelin, 2002: Data Assimilation for a Coupled Ocean-Atmosphere Model. Part I: Sequential State Estimation. *Mon. Wea. Rev.,* **130**,1,073-1,099.

Xiwu Zhan

X Zhan, J Entin, P R Houser, R H Reichle, J P Walker: "Application of Kalman Filtering for Soil Moisture Data Validation in NASA's Land Data Assimilation System", EOS, Trans. AGU, 83(19), Spring Meeting Suppl., Abstract H51D-09, 2002 (page S194).

Appendix T-3. SEMINARS, April 1, 2002 - June 30, 2002

Alexander M. Chekalyuk

A.M. Chekalyuk, F.E. Hoge, R.N. Swift, and J.K. Yungel, Superactive pump-and probe LIDAR technology: Biophysical insight into aquatic remote sensing, OSA International.

Tom Eck

Eck, T F., B. N. Holben, M. M. Mukelabai, O. Dubovik, A. Smirnov, J. S. Schafer, and I. Slutsker Seasonal Variability of Aerosol Single Scattering Albedo at Biomass Burning Sites in Southern Africa and Amazónia, AGU Spring Meeting, Washington DC, May 28-31, 2002.

Holben, B. N. , **T. F. Eck**, O. Dubovik, A. Smirnov, I. Slutsker, P. Artaxo, A. Leyva, D. Lu, I. Sano, R. P. Singh, E. Quel, D. Tanre, and G. Zibordi, AERONET - Aerosol Climatology From Megalopolis Aerosol Source Regions, AGU Spring Meeting, Washington DC, May 28-31, 2002.

Charles Gatebe

Gatebe C .K., M. D. King, and G. T. Arnold, Airborne Spectral Measurements of Ocean Anisotropy during CLAMS, Eos. Trans. AGU, 83(19), Spring Meet. Suppl., Abstract A21D-07, 2002.

Gatebe C .K., M. D. King, and G. T. Arnold, Airborne Multispectral Measurements of Bidirectional Reflectance-Distribution Using Cloud Absorption Radiometer, Third International Workshop on Multiangular Measurements and Models, Abstract 15, 2002.

Wenying, S., T. P. Charlock, C. K. Rutledge, and **C. K. Gatebe**, Ocean Reflectance Observed during CLAMS, Eos. Trans. AGU, 83(19), Spring Meet. Suppl., Abstract A21D-08, 2002.

Smith, W. L., T. P. Charlock, T. Zhang, P. V. Hobbs, **C. K. Gatebe**, R. A. Rivers, and V. E. Roback, An overview of the Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) Experiment, Eos. Trans. AGU, 83(19), Spring Meet. Suppl., Abstract A21D-02, 2002.

Gail Skofronick-Jackson

"Observations of Snowfall over Land by Microwave Radiometry from Space," by G.M. Skofronick-Jackson, J.A. Weinman, and D.-E. Chang.

Judit Pap

200th Assembly of the American Astronomical Society (AAS/SPD) Meeting, Albuquerque, NM, June 2-7, 2002.

Zhaoxia Pu

Pu, Zhaoxia, W.-K. Tao, and W. Olson, 2002: Mesoscale Assimilation of TRMM Data with 4DVAR. 5th Workshop on Application of Adjoint in Meteorology, April 21-26, 2002, Mount Bethel, PA.

Pu, Zhaoxia, Applications of Data Assimilation in Improving Atmospheric Modeling. Rutgers University, April 16, 2002.

Rolf Reichle

Reichle, R.H., R.D. Koster, Land data assimilation with the Ensemble Kalman Filter: Assessing model error parameters using innovations, Invited Presentation at the XIV International Conference on Computational Methods in Water Resources, Delft, Netherlands, June 2002
X Zhan, J Entin, P R Houser, **R H Reichle,** J P Walker: "Application of Kalman Filtering for Soil Moisture Data Assimilation in GSFC's Land Data Assimilation System", Presented at AGU Spring Meeting 2002, Washington, DC.

R H Reichle: "Lessons learned from data assimilation into uncoupled land models", Invited Presentation at the Workshop on Land-atmosphere Coupling Aspects in Land Data Assimilation and SVAT Parameter Estimation, Global Land Atmosphere System Study (GLASS), Apr. 2002, DeBilt, Netherlands.

Susan Strahan

American Geophysical Union in Washington DC, S.E. Strahan, "Influence of Planetary Wave Transport on Arctic Ozone as Observed by POAM III" - May 28, 2002. NASA/GSFC web site 5/28/02 - "A warm polar winter was easier on Arctic ozone."

Song Yang

Latent Heating Structure of Hurricanes from TRMM measurements" at the 25th Conference on Hurricane and Tropical Meteorology at San Diego Apr 29-May 3' 2nd International Planning Workshop on Global Precipitation Measurement (GPM) Tokyo during May 20-22 in Tokyo.

Appendix T-4.
Proposals Submitted & Funded – April 1 , 2002 - June 30, 2002

P.I:	**Gail Jacson - funded**
Title:	"Deriving Microphysical Cloud Profiles using Airborne Active and Wideband Passive Microwave Observations"
Sponsoring Agency:	NASA
Budget/Commitment	$78,175

P.I:	**Wenge Ni-Meister - funded**
Title:	"The Effect of Subgrid Variability of Snow Cover in Vegetated Regions on Land-Atmosphere Interactions"
Sponsoring Agency:	NASA
Budget/Commitment	$65,000

P.I:	**Judit Pap - funded**
Title:	"Study of Solar and Spectral Variations Based on SOHO/ VIRGO and MDI"
Sponsoring Agency:	NASA
Budget/Commitment	$136,748

P.I:	**Judit Pap - funded**
Title:	"The Study of the Terrestrial Effects of Solar Irradiance Variations from EUV to Infrared: A New Approach"
Sponsoring Agency:	NASA
Budget/Commitment	$66,614

P.I.	**Steven Pawson - funded**
Title:	"Reanalysis for Stratospheric Trace Gas Studies (RESTS)"
Sponsoring Agency:	NASA
Budget/Commitment	$142,235

PI:	**Song Yang - funded**
Title:	"Improvement of General Circulation Model Simulation Using Global Observations of Precipitation/Laten"
Sponsoring Agency:	NASA
Budget/Commitment	$67,178

Business Status Report

Amendments Received During this Reporting Period

Four amendments to the Cooperative Agreement were received during the present reporting period. At the start of the reporting period a total of $14,795,729 was obligated to the Cooperative Agreement. As of 6/30/02 the total financial obligation was $17,496,236. Table B.1 gives an overview of these amendments.

Table B.1. Amendments to NCC5-494, received between 4/1/02 and 6/30/02.

Amendment Number	Date	Amount	Activities Added/Augmented	Activities Deleted
31	4/18/02	15,904,376	1	0
32	5/17/02	16,771,172	3	0
33	5/31/02	17,018,787	1	0
34	6/18/02	17,496,236	0	0

The attached Table B.2 gives a detailed breakdown of the new or augmented activities in amendments 31, 32, 33, and 34.

Summary of Account Activity

The most recent cost analysis for GEST, giving actual costs accrued during the reporting period was dated 6/30/02. Table B.3 gives a detailed breakdown, by task number of the costs incurred, the approved budget and remaining balance, during the reporting period.

TABLE B-3: DETAILED COST BREAKDOWN FOR THE LAST THREE MONTHS OF THE REPORTING PERIOD

GEST Monthly Cost Analysis - April 1, 2002 - June 30, 2002

GEST Task # and Sponsor	A Salary	C Fringe	T Travel	Subcontracts	U Supplies	A Publications	Contractual	L Equipment	ODC	Total Direct Costs	Indirect	Total Costs 4/1/02-6/30/02	Total Costs thru 3/31/01	Total Year to Date	Approved Budget 7/1/01 - 6/30/02	Projected Costs	Balance Remaining as of 6/30/02
#931-00-001 Macie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#971-00-002 Rienecker/Adamec	119,248	26,755	24,722	0	0	0	0	0	0	170,725	34,145	204,870	1,141,503	1,346,373	1,722,434	0	376,062
#931-00-003 Palm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#930-00-004 Mitchell	0	0	0	0	0	0	0	0	0	0	0	0	56,494	56,494	56,494	0	0
#902-00-005 Olsen	32,721	7,365	3,600	0	288	0	0	0	0	43,974	8,795	52,769	305,099	357,868	432,000	0	74,132
#902-00-006 Olsen	32,641	6,705	0	0	0	0	0	0	0	39,346	7,869	47,215	282,634	329,849	474,148	0	144,299
#910-01-008 Hou/Rood	33,701	7,649	(8,236)	0	0	0	0	0	0	33,114	6,623	39,737	202,160	241,897	345,016	0	103,119
#910-01-009 Atlas/Hou	22,215	5,861	411	0	0	0	0	0	0	28,487	5,697	34,184	198,951	233,135	218,218	0	(14,917)
#910-01-010 Atlas	28,167	6,373	1,170	0	0	0	0	0	0	35,710	7,142	42,852	231,878	274,730	226,221	0	(48,509)
#912-01-011 Spinhirne	32,503	6,335	4,880	0	0	0	0	0	0	43,718	8,744	52,462	249,858	302,319	347,023	0	44,704
#912-01-012 Spinhirne	16,110	3,710	0	0	0	0	0	0	0	19,820	3,964	23,784	100,099	123,883	141,122	0	17,239
#910-01-014 Schoeberl	26,527	5,010	3,365	0	0	0	0	0	0	34,902	6,980	41,882	139,305	181,187	337,634	0	156,447
#916-01-016 Kawa	18,708	2,608	275	0	0	0	0	0	0	21,591	4,318	25,909	31,825	57,734	117,197	0	59,462
#916-01-017 Bhartia	509	0	0	0	0	0	0	0	0	509	231	740	14,778	15,518	15,516	0	(2)
#921-01-018 Frey	4,930	-7,490	1,767	0	0	0	0	0	26	-10,627	4,219	-6,408	252,578	246,170	243,811	0	(2,360)
#923-01-019 Deering - CAELUM	-317	0	108	0	0	0	0	0	0	-209	-185	-394	17,144	16,750	25,000	0	8,250
#930-01-020 Fischer - CAELUM	52	0	0	0	0	0	0	0	0	52	10	62	882	944	15,000	0	14,056
#930-01-021 Fischer	0	0	0	0	0	0	0	0	0	0	0	0	17,277	17,277	57,277	0	40,000
#935-01-022 Dorband	20,218	5,149	464	0	0	0	0	0	0	25,831	5,166	30,997	182,583	213,580	297,461	0	83,881
#930-01-023 Fischer	26,844	6,647	390	0	0	0	0	0	0	33,881	6,776	40,657	251,933	292,590	350,000	0	57,410
#930-01-024 Fischer	0	0	0	0	0	0	0	0	0	0	0	0	3,718	3,718	5,380	0	1,662
#912-02-027 Heymsfield	15,403	2,224	300	0	0	0	0	0	0	17,927	3,585	21,512	116,736	138,248	180,883	0	42,635
#912-02-029 Tao	16,594	4,972	1,372	0	0	0	0	0	0	22,938	4,588	27,526	136,726	164,251	175,400	0	11,149
#912-02-034 Tao/Negri	0	0	0	0	0	0	0	0	0	0	0	0	49,019	49,019	49,020	0	1
#913-02-035 Chao	13,626	4,166	1,303	0	0	0	0	0	0	19,095	3,819	22,914	103,789	126,703	145,988	0	19,285
#912-02-036 Starr	14,521	3,222	2,832	0	0	0	0	0	0	20,575	4,115	24,690	110,821	135,511	159,875	0	24,364
#913-02-037 Lau - CAELUM	583	0	982	0	0	0	0	0	0	1,565	405	1,970	6,101	8,071	10,000	0	1,929
#913-02-038 Kaufman - CAELUM	4,276	0	20,166	0	0	0	0	0	0	24,442	4,537	28,979	35,670	64,649	39,241	0	(25,408)
#971-02-040 Hakkinen	16,167	3,793	290	0	0	0	0	0	0	20,250	4,050	24,300	134,944	159,244	228,354	0	69,110
#900-03-041 King	0	0	0	0	0	0	0	0	0	0	0	0	136,720	136,720	125,000	0	(11,720)
#910-03-042 Cohn - CAELUM	1,679	0	1,119	0	0	0	0	0	58	2,856	1,052	3,908	24,206	28,114	40,000	0	11,886
#910-03-043 Richards - CAELUM	1,161	0	2,321	0	0	0	0	0	40	3,522	956	4,478	71,987	76,465	70,509	0	(5,956)
#910-03-047 Richards	36,932	8,379	18,041	0	0	0	0	0	0	63,352	12,670	76,022	104,843	180,865	355,597	0	174,732
#912-03-064 Negri - CAELUM	311	0	662	0	0	0	0	0	0	973	420	1,393	9,728	11,121	6,139	0	(4,982)
#913-03-065 Lau	0	0	0	0	0	0	0	0	0	0	0	0	36,227	36,227	36,227	0	0
#913-03-066 Lau	0	0	0	0	0	0	0	0	0	0	0	0	41,698	41,698	41,898	0	200
#923-03-067 Holben	63,864	17,030	3,780	0	0	0	0	0	0	84,674	16,935	101,609	312,563	414,172	537,000	0	122,828
#930-03-068 Halem	20,552	3,512	0	0	0	0	0	0	0	24,064	4,813	28,877	223,408	252,285	342,820	0	90,535
#935-03-069 Coronado/Shamann	-2,899	0	0	0	0	0	0	0	0	-2,899	-1,687	-4,586	130,693	126,107	142,111	0	16,004
#974-03-070 Houser	195,960	39,091	14,997	0	0	0	0	0	428	250,476	54,295	304,771	893,551	1,198,322	1,360,740	0	162,418
#693-04-073 Reuter	0	0	0	0	0	0	0	0	0	0	0	0	19,783	19,783	20,802	0	1,019
#910-04-074 Rood	36,408	9,173	385	0	0	0	0	0	0	45,966	9,193	55,159	235,269	290,428	342,000	0	51,572
#916-04-076 Herman/Krueger	10,472	2,800	351	0	0	0	0	0	0	13,623	2,725	16,348	168,267	184,615	236,212	0	51,597
#930-04-077 Halem	441	0	0	0	0	0	0	0	0	441	197	638	50,088	50,726	28,351	0	(22,376)
#586-05-081 Behnke	6,081	735	0	0	0	0	0	0	0	6,816	1,363	8,179	73,745	81,924	100,000	0	18,076
#910-05-082 Rood	13,402	2,600	550	0	0	0	0	0	0	16,552	3,310	19,862	85,310	105,172	137,000	0	31,828
#130-05-083 Gabrys	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(14,656)	0	(14,656)
#550-05-084 Lyon	0	0	0	0	0	0	0	0	0	0	0	0	54,281	54,281	113,300	0	59,019
#130-05-085 Gabrys	24,784	6,388	1,414	0	0	0	0	0	0	32,586	6,555	39,141	218,151	257,292	389,045	0	131,753
#974-05-086 Chang	18,245	3,932	1,558	0	0	0	0	0	0	23,735	4,747	28,482	141,163	169,645	220,582	0	50,937

TABLE B-3. DETAILED COST BREAKDOWN FOR THE LAST THREE MONTHS OF THE REPORTING PERIOD

GEST Monthly Cost Analysis - April 1, 2002 - June 30, 2002

GEST Task # and Sponsor	A Salary	C Fringe	T Travel	Subcontracts	U Supplies	A Publications	Contractual	L Equipment	ODC	Total Direct Costs	Indirect	Total Costs 4/1/02-6/30/02	Total Costs thru 3/31/01	Total Year to Date	Approved Budget 7/1/01 - 6/30/02	Projected Costs	Balance Remaining as of 6/30/02
#550-06-087 Lyon	18,819	5,372	908	0	0	0	0	0	0	25,099	5,020	30,119	171,736	201,855	228,953	0	27,098
#912-06-088 Spinhirne	15,190	3,193	2,149	0	0	0	0	0	0	20,532	4,106	24,638	124,028	148,666	180,418	0	31,751
#910-06-091 Schoeberl	0	0	0	0	0	0	0	0	0	0	0	0	22,408	22,408	22,408	0	0
#923-06-092 Tucker	16,751	3,435	0	0	0	0	0	0	0	20,186	4,037	24,223	135,252	159,475	157,429	0	(2,046)
#935-06-094 Le Moigne	163	0	0	0	0	0	0	0	0	163	71	234	7,092	7,326	10,000	0	2,674
#926-07-096 Chao - CAELUM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33,337	0	33,337
#681-08-097 Bowers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(35,000)	0	(35,000)
#910-08-098 Hou	14,549	3,048	980	0	0	0	0	0	0	18,577	3,715	22,292	31,774	54,066	80,000	0	25,934
#910-08-099 Atlas	33,855	9,136	0	0	0	0	0	0	0	42,991	8,598	51,589	221,991	273,580	260,452	0	(13,128)
#910-08-100 da Silva	0	0	0	0	0	0	0	0	0	0	0	0	49,510	49,510	76,104	0	26,594
#916-08-101 Herman	14,176	2,872	3,393	0	0	0	0	0	0	20,441	4,126	24,567	91,635	116,202	209,730	0	93,528
#930-08-102 Gabrys	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,267	0	10,267
#902-09-103 Olsen	0	0	0	0	0	0	0	0	0	0	0	0	209,667	209,667	214,600	0	4,933
#970-09-104 Ormsby - CAELUM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#970-09-105 Ormsby - CAELUM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#971-09-106 Bindschadler	0	0	0	0	0	0	0	0	0	0	0	0	31,659	31,659	35,800	0	4,141
#971-10-107 Liu	161	0	166	0	0	0	1,563	0	0	1,890	94	1,984	1,107	3,091	10,000	0	6,909
#912-10-108 Spinhirne	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#912-10-109 Tao	16,855	5,068	1,366	0	0	0	0	0	0	23,289	4,658	27,947	88,887	116,834	107,505	0	(9,329)
#931-10-110 Zlesak/Fischer	4,389	0	1,160	0	0	0	0	0	0	5,549	2,062	7,611	71,998	79,609	86,841	0	7,232
#931-10-111 Lawrence	1,125	0	3,856	0	0	0	0	0	0	4,981	1,078	6,059	15,313	21,372	80,000	0	58,628
#903-11-112 Reising	872	0	1,280	0	0	0	0	0	0	2,152	771	2,923	103,428	106,351	124,657	0	18,306
#935-11-113 LeMoigne	3,192	246	0	0	0	0	0	0	0	3,438	688	4,126	26,794	30,920	45,000	0	14,080
#930-11-114 Mack/Halem	-985	0	0	0	0	0	0	0	0	-985	-536	-1,521	165,130	163,609	149,060	0	(14,549)
#930-12-115 Spicer	22,865	4,398	416	0	0	0	0	0	0	27,679	5,536	33,215	117,639	150,854	262,723	0	111,869
#912-10-116 Tao	19,138	4,769	0	0	0	0	0	0	0	23,907	4,781	28,688	97,396	126,084	165,298	0	39,214
#913-12-117 Lau	18,921	4,107	54	0	0	0	0	0	0	23,082	4,616	27,698	93,425	121,123	148,968	0	27,845
#913-12-118 Wiscombe	0	0	0	0	0	0	0	0	0	0	0	0	87,466	87,466	85,000	0	85,000
#972-13-119 Vandemark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13,200	0	13,200
#913-13-120 Tsay	20,172	4,927	0	0	0	0	0	0	0	25,099	5,019	30,118	101,733	131,851	147,750	0	15,899
#916-13-121 Gleason	17,871	3,714	0	0	0	0	0	0	0	21,585	4,317	25,902	95,072	120,974	158,200	0	37,226
#423-14-122 Behnke	0	0	0	0	0	0	0	0	0	0	0	0	23,611	23,611	50,000	0	26,389
#910-14-123 Schubert	19,547	4,880	21	0	0	0	0	0	0	24,448	4,890	29,338	56,193	85,531	136,600	0	51,069
#910-14-124 Hou	17,871	3,604	1,257	0	0	0	0	0	0	22,732	4,546	27,278	76,401	103,679	121,000	0	17,321
#910-14-125 Lin	16,475	3,397	1,296	0	0	0	0	0	1,296	22,464	4,493	26,957	23,455	50,412	82,355	0	31,943
#975-14-126 Kim	0	0	0	0	0	0	0	0	0	0	0	0	8,925	8,925	9,155	0	230
#935-16-127 LeMoigne	714	0	-1,534	0	0	0	0	0	0	-820	423	-397	12,782	12,385	33,608	0	21,223
#930-16-128 Degnan	4,659	0	45	0	0	0	0	0	0	4,704	941	5,645	56,510	62,155	40,000	0	(22,155)
#912-18-129 Braun	0	0	0	0	0	0	0	0	0	0	0	0	605	605	74,469	0	73,864
#913-18-130 Bell	17,871	2,581	0	0	0	0	0	0	0	20,452	4,090	24,542	45,638	70,180	91,848	0	21,668
#912-19-131 Heymsfield	17,154	4,618	2,448	0	0	0	0	0	0	24,220	4,844	29,064	46,343	75,407	136,716	0	61,309
#926-19-132 Chao, Ben	12,565	1,823	0	0	0	0	0	0	0	14,388	2,878	17,266	30,475	47,741	83,500	0	35,759
#915-19-133 Niemann	0	0	316	0	0	0	0	0	0	316	63	379	2,654	3,033	100,000	0	96,967
#915-19-134 LeMoigne	12,733	4,017	1,732	0	0	0	0	0	0	18,482	3,696	22,178	38,593	60,771	73,902	0	13,131
#910-19-135 Pawson	12,715	1,534	4,631	0	0	0	0	0	0	18,880	3,776	22,656	1,442	24,098	43,606	0	19,508
#900-19-136 King	15,342	1,401	0	0	0	0	0	0	0	16,743	3,349	20,092	23,387	43,479	75,500	0	32,021
#971-20-137 Koblinsky	6,962	736	0	0	0	0	0	0	11	7,709	1,542	9,251	0	9,251	77,500	0	68,249
#910-20-138 DaSilva	15,385	4,873	290	0	0	0	0	0	0	20,548	4,110	24,658	21,396	46,054	155,584	0	109,530
#912-21-140 Adler	4,104	316	0	0	0	0	0	0	0	4,420	0	4,420	429	4,849	115,755	0	110,906
#900-21-141 Meeson	-28	0	2,483	0	0	0	0	0	0	2,455	354	2,809	2,767	5,576	24,765	0	19,189
#924-21-142 Whiteman	15,381	3,349	6,088	0	0	0	0	0	0	24,818	4,964	29,782	13,770	43,552	39,356	0	(4,196)

TABLE B-3. DETAILED COST BREAKDOWN FOR THE LAST THREE MONTHS OF THE REPORTING PERIOD

GEST Monthly Cost Analysis - April 1, 2002 - June 30, 2002

GEST Task # and Sponsor	A Salary	C Fringe	T Travel	Subcontracts	U Supplies	A Publications	Contractual	L Equipment	ODC	Total Direct Costs	Indirect	Total Costs 4/1/02-6/30/02	Total Costs thru 3/31/01	Total Year to Date	Approved Budget 7/1/01 - 6/30/02	Projected Costs	Balance Remaining as of 6/30/02
#972-21-143 Gerlach	0	0	0	0	0	0	0	0	0	0	0	0	16,956	16,956	112,000	0	95,044
#916-21-144 Chandra	11,603	2,104	0	0	0	0	0	0	0	13,707	2,741	16,448	5,357	21,805	92,500	0	70,695
#912-21-145 Adler	18,143	4,064	15	0	0	0	0	0	15	22,237	4,447	26,684	5,993	32,677	56,697	0	24,020
#913-21-146 Calahan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50,000	0	50,000
#912-23-147 Smith, E.	25,744	4,208	2,474	0	0	0	0	0	0	32,426	10,137	42,563	17,946	60,509	497,618	0	437,109
#920-25-148 Carter, D.	-6,440	0	0	0	0	0	0	0	0	-6,440	-747	-7,187	7,315	128	5,000	0	4,872
#971-26-149 Hakkinen	13,943	1,553	613	0	0	0	0	0	24	16,133	0	16,133	0	16,133	58,679	0	42,546
#920-25-150 Houser	2,806	0	2,249	0	0	0	0	0	-8	5,047	1,542	6,589	34	6,623	4,000	0	(2,623)
#900-29-151 King	16,188	4,315	70	0	0	0	0	0	0	20,573	4,115	24,688	0	24,688	118,481	0	93,793
#912-29-152 Tao	0	0	2,023	0	0	0	0	0	0	2,023	405	2,428	0	2,428	40,000	0	37,572
#930-30-153 Mack/Halem	28,612	0	0	0	0	0	0	0	0	15,548	44,160	59,708	0	59,708	19,625	0	(40,083)
#975-31-154 Kim	0	0	1,166	0	0	0	0	0	0	1,166	233	1,399	0	1,399	76,630	0	75,231
#910-31-155 Gelaro	0	0	455	0	0	0	0	0	0	455	89	544	0	544	86,000	0	85,456
#970-31-156 Barnes	2,573	0	0	0	0	0	0	0	0	2,573	1,518	4,091	0	4,091	45,000	0	40,909
#912-31-157 Whiteman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30,000	0	30,000
#975-32-159 Meneghini	1,437	0	0	0	0	0	0	0	0	1,437	848	2,285	0	2,285	70,036	0	67,751
#972-32-160 Gerlach	6,469	0	2,509	0	0	0	0	0	0	8,978	4,181	13,159	0	13,159	50,000	0	36,841
#971-32-161 Liu	2,611	0	0	0	0	0	0	0	0	2,611	1,541	4,152	0	4,152	38,533	0	34,381
#923-32-162 Privette	0	0	395	0	0	0	0	0	395	790	0	790	0	790	150,000	0	149,210
#935-32-163 Lyon	13,031	1,424	0	0	0	0	0	0	0	14,455	2,891	17,346	0	17,346	60,000	0	42,654
#903-33-165 Reising	18,174	0	7,713	0	0	0	0	1,500	61	27,448	11,163	38,611	0	38,611	85,129	0	46,518
#930-33-166 Spicer, E.	285	0	0	0	0	0	0	0	0	285	168	453	0	453	70,000	0	69,547
Totals	1,496,188	303,776	159,822	0	288	0	1,563	1,500	2,346	1,952,419	454,287	2,406,706	10,107,298	12,514,004	17,496,236	0	5,069,698

STAGE SEPARATION PERFORMANCE DYNAMIC ANALYSIS

Progress Report

Order Number: NAS8-02058

Prepared for

National Aeronautics and Space Administration
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STAGE SEPARATION PERFORMANCE DYNAMIC ANALYSIS

OBJECTIVES

Stage separation process is an important phenomenon in multi-stage launch vehicle operation. The transient flowfield coupled with the multi-body systems is a challenging problem in design analysis. The thermodynamics environment with burning propellants during the upper-stage engine start in the separation processes adds to the complexity of the entire system. Understanding the underlying flow physics and vehicle dynamics during stage separation is required in designing a multi-stage launch vehicle with good flight performance. A computational fluid dynamics model with the capability to coupling transient multi-body dynamics systems will be a useful tool for simulating the effects of transient flowfield, plume/jet heating and vehicle dynamics. A computational model using generalize mesh system will be used as the basis of this development. The multi-body dynamics system will be solved, by integrating a system of six-degree-of-freedom equations of motion with high accuracy. Multi-body mesh system and their interactions are modeled using parallel computing algorithms. Dynamic stage separation CFD model will be developed with multiple-body detaching mechanism, body contact detection method and plume impingement heating effects modeled. The following tasks are proposed to accomplish the technical objectives.

TASKS ACCOMPLISHED IN THIS REPORTING PERIOD

Isolated LGBB Aerodynamics Analysis

Computations and data analyses of the LGBB isolated vehicle configuration have been performed. A new grid is generated to include a single vehicle in a domain representing the wind tunnel. The total number of elements for this case is 410,569. The freestream velocity, pressure and temperature are 645.95 m/s, 0.065879 ATM and 116.1403 K respectively. This gives the freestream Mach number of 2.99. A baseline case with zero angles of attack is analyzed. Subsequent cases were then computed with 2 degrees increment in angles of attack. A total of 12 cases for angles of attack from –4 degrees to 18 degrees were solved. The clustered PC computer system, chimaera, of NASA/MSFC is provided to test the parallel computational performance. Five computer nodes with total of 10 processors were used for the computations. This provides a very quick turnaround for each case. The baseline (zero angles of attack) case took 5000 time steps to get a converged solution, which took about 5 hours wall clock time to complete. A converged solution is obtained when the integrated normal and axial forces reached steady-state values. Each subsequent cases with angles of attack increment of decrement took another 3000 time steps (or 3 hours wall clock time) to complete. Therefore, all 12 cases were solved within 3

working days. This reveals the power of the clustered PC system for doing real engineering analysis using the present CFD model.

The integrated normal force, axial force and pitching moment coefficients are collected and plotted against the measured data from the wind tunnel tests conducted at NASA/MSFC. Figures 1 to 3 show the results of data comparisons. It is clear that the present model gives good agreements between predicted and measured normal and axial force coefficients. Comparisons in pitching moment coefficients also show good agreements for angles of attack less than 8 degrees. Discrepancies for higher angles of attack cases are unclear at this moment. The leveling off in the measured pitching moment for angles of attack higher than 8 degrees indicates the possibility of flow separation (or vortex breakdown) along the wing upper surface. However, the CN curve does not give such indication.

To resolve the issue of data discrepancies in pitching moment coefficients, adaptive mesh cases will be analyzed to reveal more information about the flowfield for high angles of attack conditions.

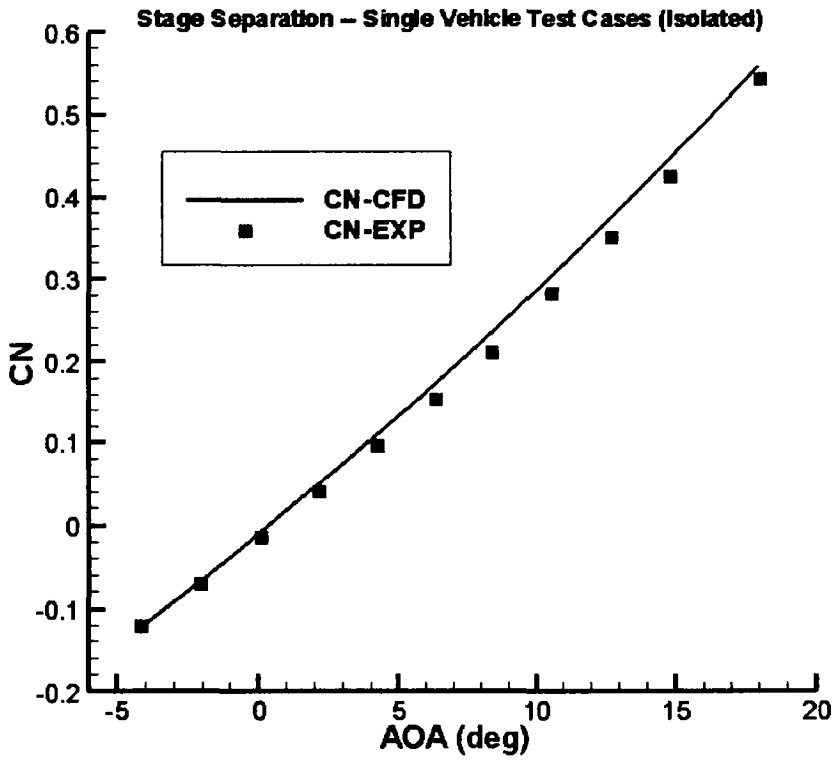

Figure 2. Comparisons of normal force coefficients.

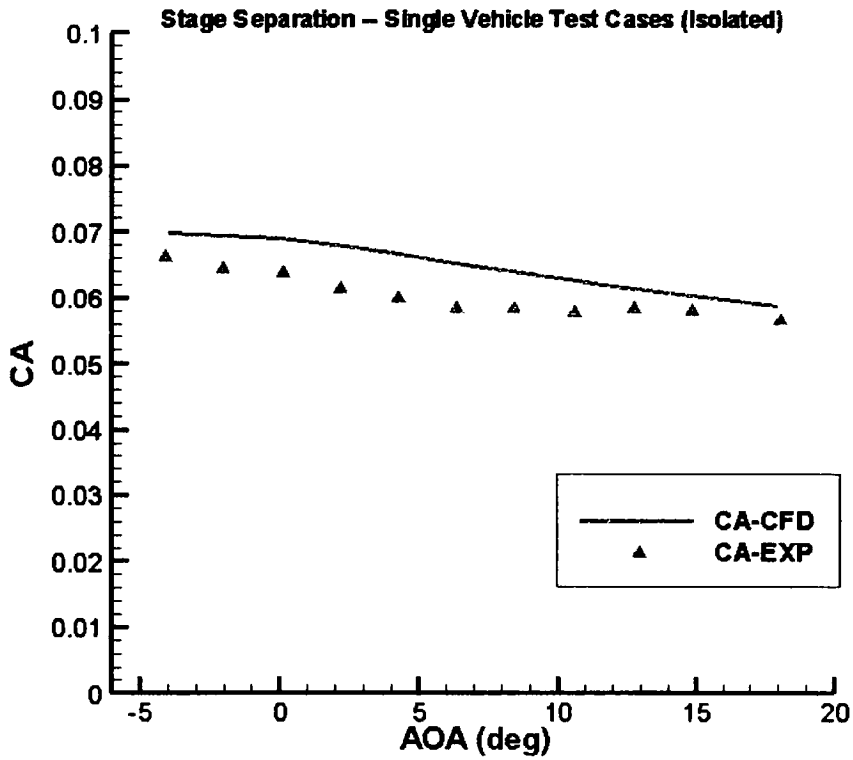

Figure 2. Comparisons of axial force coefficients.

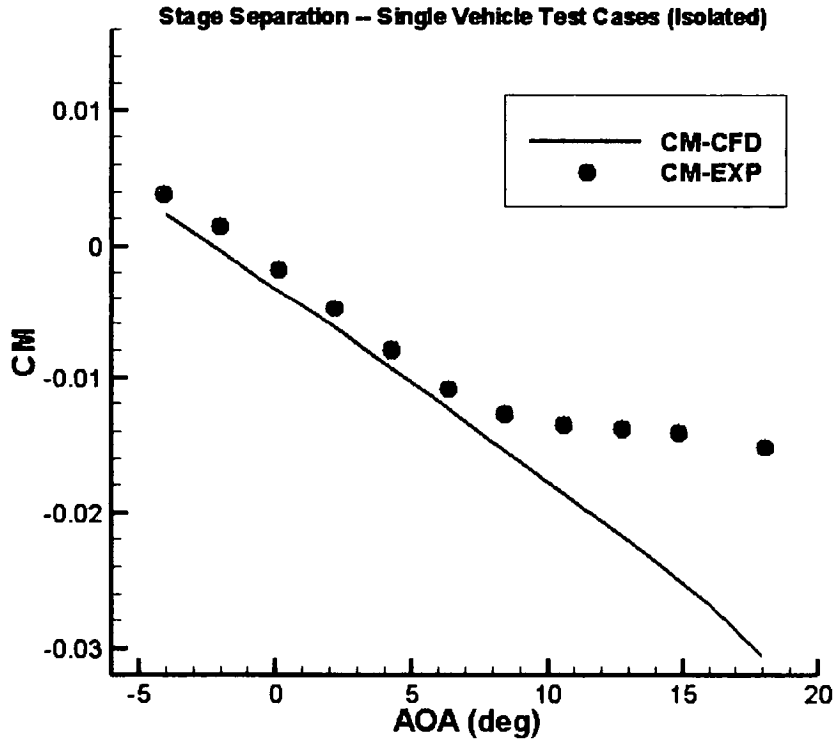

Figure 3. Comparisons of pitching moment coefficients.

Dynamic Chimera Grid Model Development

The development of a general methodology for simulating dynamic stage separation configuration using overset grid systems is continued in this reporting period. The basic database for handling the interpolation procedures among systems of overset grid is under construction. Procedure optimization and overall process efficiency is the major concern for good computational speed and solution robustness in the long run. Following the database construction, the performance of the general interpolation procedure will be tested and fine-tuned for seamless operations, which will be performed in the next reporting period.

TASKS TO BE PERFORMED IN THE NEXT PERIOD

1. Analyze the single vehicle test cases with adaptive grid method.
2. Continue formulation and implementation of the overset dynamic Chimera grid model.

CONTRACT PERFORMANCE AND FUNDING

58.33% of the proposed technical effort has been accomplished with 58.33% of the funding billed. No technical problem of the current model development has been encountered.

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13. ABSTRACT *(Maximum 200 words)*

Stage separation process is an important phenomenon in multi-stage launch vehicle operation. The transient flowfield coupled with the multi-body systems is a challenging problem in design analysis. The thermodynamics environment with burning propellants during the upper-stage engine start in the separation processes adds to the complexity of the entire system. Understanding the underlying flow physics and vehicle dynamics during stage separation is required in designing a multi-stage launch vehicle with good flight performance. A computational fluid dynamics model with the capability to coupling transient multi-body dynamics systems will be a useful tool for simulating the effects of transient flowfield, plume/jet heating and vehicle dynamics. A computational model using generalize mesh system will be used as the basis of this development. The multi-body dynamics system will be solved, by integrating a system of six-degree-of-freedom equations of motion with high accuracy. Multi-body mesh system and their interactions are modeled using parallel computing algorithms. Dynamic stage separation CFD model will be developed with multiple-body detaching mechanism, body contact detection method and plume impingement heating effects modeled.

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